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The Compilation and Analyses of 2015 Input-Output Tables for All Municipalities in Japan

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The Compilation and Analyses of 2015 Input-Output Tables for All Municipalities in Japan[1]

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1. Introduction

Suga (2019) estimated Input-Output Tables (IOT) for all municipalities by aggregating micro data of sales (revenue) data by industry and municipality in the 2012 Economic Census-Activity Survey (EC-AS) together with the finalized 2011 IOT. The study initiated by Suga (2019) was intended to raise public awareness of the just-launched EC-AS by having the results of the survey used for analysis in regions (municipalities) familiar to the presenter and by spurring examples of the use of analysis results to contribute to regional policy making. Some studies which utilized the estimated results provided by Suga (2019) were those from Yamada (2020), Yamada (2022), and Funabashi (2021).

The 2016 EC-AS used 2015 as the reference year, and this study extends Suga's (2019) 2011 estimates to 2015. Essentially, this study used the micro data of the 2016 EC-AS to estimate sales (revenue) by industry and municipality. Subsequently, it estimates IOT for all municipalities using data from the final version of 2015 IOT.

This study has been prepared as a teaching material for training conducted at the Statistical Research and Training Institute and is part of a joint research project between the Institute and Suga.

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[1] This article is an English translation of Suga, Ide, Ishiro, Watanabe, Inoda, Suhara (2023)"The Compilation and Analyses of 2015 Input-Output Tables for All Municipalities in Japan," *Bulletin of Japanese Statistics Research Institute*, No.57 written in Japanese. The contents of this paper were reported at the national conference of the Pan-Pacific Association of Input-Output Studies (PAPAIOS), held in October 2022. Yamada Mitsuo provided highly valuable feedback on that occasion. We would like to take the opportunity to express our gratitude. Responsibility for any errors in this paper lies with its authors.

2. Flow of Estimation

Sales (revenue) by industry and municipality were aggregated from micro data of sales (revenue) by establishments across all industries in the 2016 EC-AS. In doing so, concealed values were supplemented. After adjusting sales by industry and municipality with the output concept of the IOT, output by product and municipality was obtained using the output by product and industry table (V table). Head office output by municipality was also added. Meanwhile, the head office sector was added to the 2015 IOT using the head office matrix of the 2015 IOT. The municipal IOT was estimated using output by product and municipality and the intermediate input coefficients from the 2015 IOT (with head office sector).

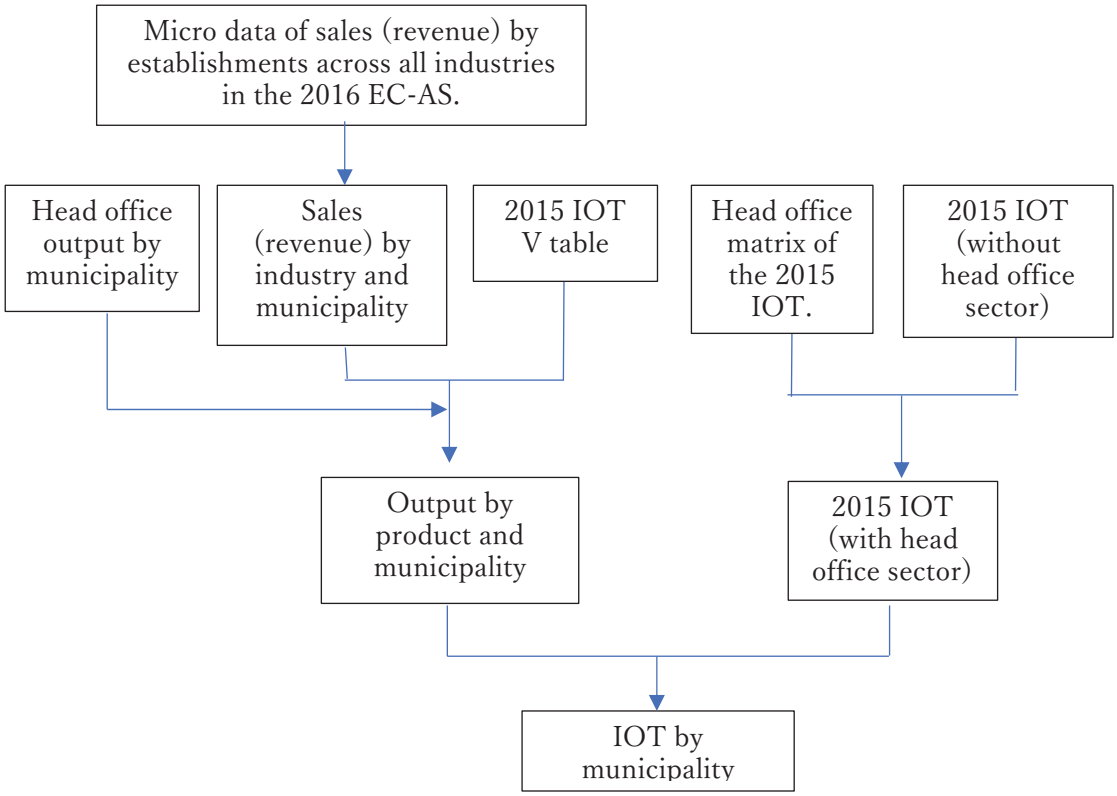

Figure 2.1 Flow of Estimation

3. Aggregation and Imputation of Sales (Revenue) from the Micro Data of the EC-AS

First, special tabulations were made using micro data from the 2016 EC-AS at the on-site laboratory in the Bureau of Statistics, which is one of bureaus of the Ministry of Internal Affairs and Communications (MIC). In compliance with statistics law, cells with two or fewer establishments in the table were kept concealed to protect individual information. The Bureau of Statistics reviewed the results before being provided online to us.

Next, we imputed concealed values by the method which is similar to the RAS. Specifically, the following process (1) ~ (16) was used for each prefecture.[2]

(1) We entered estimated sales (revenue) as the initial value in the positions of the concealed cells of the table.[3] The important thing here is the number of employees is published for all municipalities and industries from MIC. We, therefore, calculated the inter-prefecture average sales revenue per capita by industry and multiplied it by the number of employees per municipality to estimate hidden municipality/industry sales (revenue).

(2) We calculate the difference between the total value of unconcealed cells and the total value when including concealed values (i.e., the total value of the concealed values) by industry and municipality. Total values, including concealed values, were compiled directly from the micro data and are in close agreement with the published values.

(3) The industry (horizontal) composition ratio is calculated and then multiplied by the difference values for each municipality.

(4) For the table calculated in the previous step, we calculated the (vertical) composition ratios by municipality and multiply them by the industry-specific difference values.

(5) For the table calculated in the previous step, calculate the industry (horizontal) composition ratio and multiply it by the difference value for each municipality.

(6) Repeat steps (4) and (5) 20 times. Convergence occurs after 20 iterations.

This process made it possible to impute concealed values such that the vertical and horizontal totals matched the total, including concealed values. At this time, non-concealed cells were not changed. Note that there are multiple concealed cells by industry, and the number of such cells is quite large due to the industry subcategories. For this reason, the results following supplementation may not match the original survey results.

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[2] Note that there are multiple concealed cells by industry, and the number of such cells is quite large due to the industry subcategories.

[3] In Suga (2022), 1 was entered as the initial value.

4. Estimation of Head Office Sector

In 2015 IOT, MIC published "Head Office Matrix Table" which shows inputs of head office activities by sector. Since this estimation is based on the "Head Office Matrix Table" in the 2015 IOT, there is no need to estimate a head office table (nationwide) in principle. It is possible, however, that the values in the "Head Office Matrix Table" may exceed the corresponding cells in the 2015 IOT. This is because "Head Office Matrix Table" is an interim table before IOT rebalancing. Here, the ratio of the value added in the head office survey to the value added in the trade basic table (including offices other than the head office) was used and multiplied by the value of the corresponding cell in the trade basic table to reach an estimate. For example, as shown in Table 4.1, for printing, plate-making, and bookbinding forestry industry inputs, the value in the "Head Office Matrix Reference Table" is ¥185 million, while the value in the corresponding cell of the trade basic table is ¥23 million. Therefore, as demonstrated in Table 4.2, the ratio of gross value added by forestry sector head office activities, ¥10281 million, to the value added presented in the trade basic table (including activities outside of the head office), ¥532118 million, i.e., 10,281/532,118 = 0.0193209, multiplied by the value of the corresponding cell in the trade basic table, ¥23 million, was used to arrive at an estimated value of 0.0193209×23＝¥0.444381 million (rounded to the nearest million). The gross value added of head office activities is lower than the gross value added for all sectors in the trade basic table (including non-head office activities).

Note that the total head office input estimated using this method does not match the value of head office output as-is. Therefore, to ensure that total head office input matches the total value of head office output, the difference between the two is placed in the corresponding input (input head office services to head office activities). The forestry sector's own input for head offices activities is approximately ¥4.116 billion.

A table was created separating the head office table from the trade basic table, and we refer to this table as the "work-site operations table." The forestry sector's head office services input was ¥14.679 billion, which is smaller than the value of the sector's head offices output of ¥18.795 billion due to the ¥4.116 billion input from head offices activities.

Next, we take the row sum of the re-estimated to the head offices table (nationwide) and merge it into a vector for head office. We then proportionally distribute the value of national head office output using the number of employees for all industries A-R of head office offices by industry and municipality from the 2016 EC-AS. In this way, we obtain head office output by municipality. At the same time, we also obtained the head office sector 1 vector, prorated by municipality.

Table 4.1 Example of "Input of printing, platemaking and bookbinding in forestry"

Comparison of Output Vales

The trade basic table				
	Crop cultivation	…	**Forestry**	Fishery
Crop cultivation	212,720		1,810	0
⋮				
Printing, plate making and book binding	698		**23**	725
Chemical fertilizer	323,372		73	0
Reference Table of the Head Office Matrix				
	Crop cultivation	…	**Forestry**	Fishery
Crop cultivation	0		0	0
⋮				
Printing, plate making and book binding	921		**185**	173
Chemical fertilizer	0		0	0

Table 4.2 Example of "Input of printing, platemaking and bookbinding in forestry"

Comparison of Gross Value Added

The trade basic table				
	Crop cultivation	…	**Forestry**	Fishery
Crop cultivation	212,720		1,810	0
⋮				
Total of gross value added sectors	3,271,985		**532,118**	879,653
Domestic production (gross inputs)	5,997,042		800,154	1,597,578
Reference Table of the Head Office Matrix				
	Crop cultivation	…	**Forestry**	Fishery
Crop cultivation	0		0	0
⋮				
the gross added value of head office activities	106,004		**10,281**	74,978
Total expenses of head office activities	182,574		18,795	101,732

The top 20 municipalities in terms of head office output calculated in this way are as follows: Osaka City, which boasts the largest value, has an area 10–20 times that of the following three values, the three central Tokyo wards, namely Chiyoda, Minato, and Chuo, and is less than half the value of the total ¥5.6447 trillion of those three Tokyo wards combined. In addition, looking at the top 20 cities and wards in terms of head office output, Tokyo's 23 wards are comparable to regional cities, to the point where we can say, "Shinagawa Ward has a smaller head office output than Sapporo, but larger than Kobe." It can also be seen that Koto Ward and Hiroshima City, Saitama City and Sendai City, and Bunkyo Ward and Ota Ward are comparable in terms of the scale of head office output.

Table 4.3 Top 20 Municipalities for Head Office Output Value (Unit: Million Yen)

1	Osaka	2,121,059	11	Sapporo	655,732
2	Chiyoda	2,082,618	12	Shinagawa	612,598
3	Minato	2,025,057	13	Kobe	509,217
4	Chuo	1,537,058	14	Koto	475,373
5	Nagoya	1,151,594	15	Hiroshima	440,574
6	Yokohama	1,001,106	16	Kawasaki	367,225
7	Shinjuku	936,236	17	Saitama	313,746
8	Shibuya	767,980	18	Sendai	312,237
9	Kyoto	690,239	19	Bunkyo	293,819
10	Fukuoka	672,833	20	Ota	292,825

Table 4.4 compares these values with existing published values. The national value of head office output in the Tokyo table is ¥82.2509 trillion, while the estimate in this study is ¥43.1043 trillion , about half that value. This is because estimates were based on the Head Office Matrix Reference Table. The Tokyo Metropolitan Area accounts for 37% and other regions 63% of the national head office output in the Tokyo Metropolis table, while Tokyo accounts for 27% and other regions 73% in this study's estimates; this estimate thus captures a greater extent the output of head office in other regions.

In addition, head office is estimated in the 2015 table for Nagoya City. The head office output for Nagoya City includes expenses required for administrative activities and activities supporting output activities at the head offices of multi-location companies located within the city: "Administrative activities include activities in administrative departments such as general affairs, human resources,

legal, accounting, business planning, while activities supporting output activities include activities by the research and development department, by the information systems department, transportation and storage activities, and public-relations related activities" (Nagoya City, 2022, p.68). The method of estimation is based on the "2015 Survey of Enterprises' Management Activities" (MIC), which surveys information such as the composition of expenses spent on management activities at head office, sales, and profits per enterprise or organization, and general administrative expenses" (Nagoya City, p.69). Although details of the estimation process are unclear, we did not find any significant difference between Nagoya's head offices output of ¥974.4 billion in the 2015 table and that of the ¥1.1516 trillion in this estimate.

Table 4.4 Comparison of Head Office Output Value (2015)

Area	Source	Head office output (Yen, Millions)
Nationwide	National Table	43,104,342
	Tokyo Table	82,250,881
	This estimation	43,104,342
Tokyo Metropolitan Area	Tokyo Table	30,707,469
	This estimation	11,792,091
Nagoya City	This estimation	1,151,594
	Nagoya City	974,410

Figure 4.1 then compares the head office input structure in the Tokyo IOT and this estimation. Tokyo, other areas, and the nation as a whole show large inputs in advertising and other business services such as real estate brokerage and leasing. On the other hand, as mentioned earlier, in this estimation, total head office input is made to equal total head office output; the difference between the two is treated as head office input, meaning that only in this estimation is head office input large.

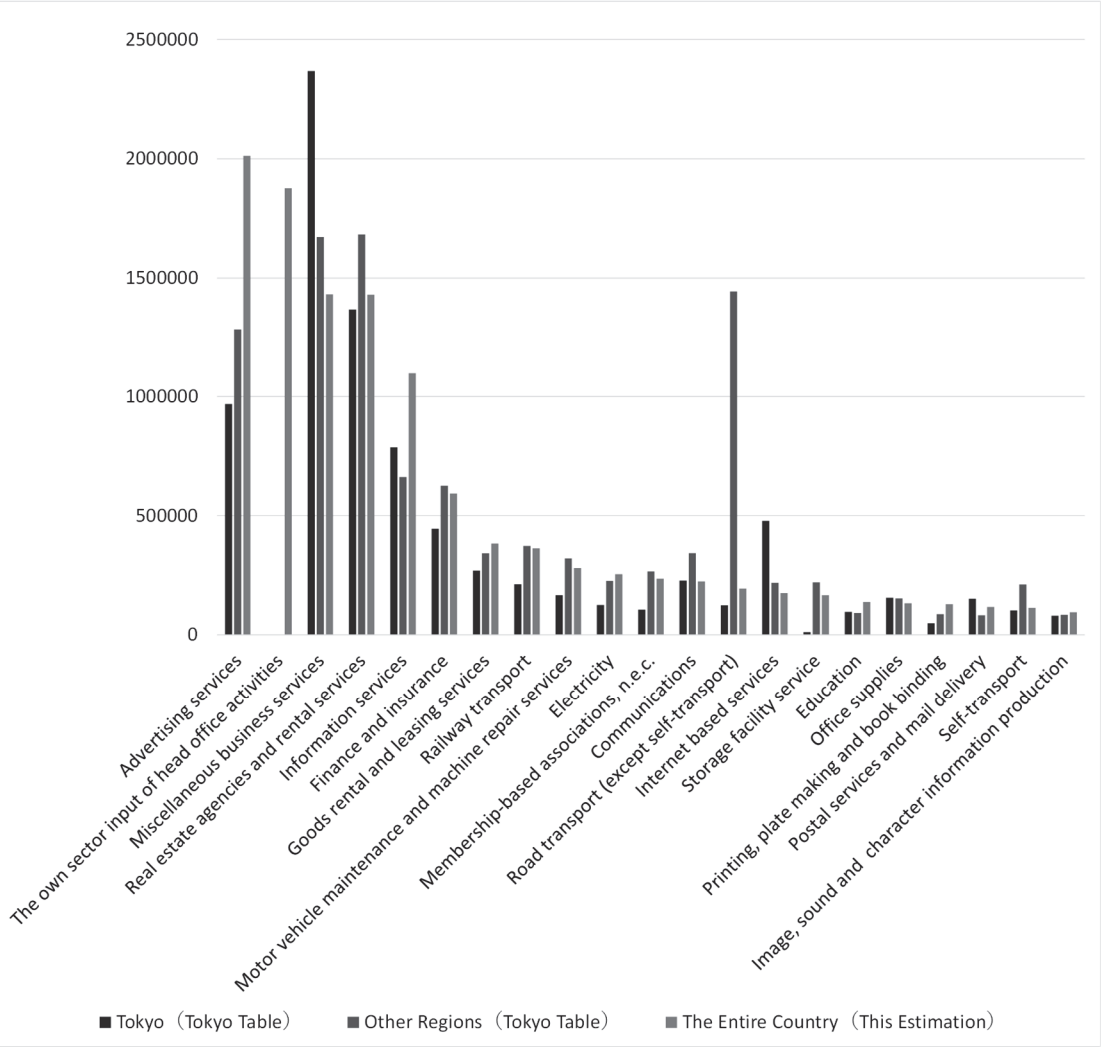

Figure 4.1 Comparison of the Input Structure of the Head Office

5. Estimation of the Agriculture, Forestry, and Fisheries Sectors

The estimation of the agriculture, forestry, and fishery sectors were based on various statistics published by the Ministry of Agriculture, Forestry, and Fisheries (MAFF). This is to create estimates for these sectors more consistent with the true situation, given that the Economic Census does not include privately owned establishments in its survey.

For agricultural sector output, we used the "Agricultural Output by Municipality (Estimates)" (2015) prepared by the MAFF. This was created by proportionally dividing prefectural agricultural output using the Agriculture and Forestry Census and crop statistics.

In addition, this municipal agricultural output does not estimate data by administrative districts for ordinance-designated cities. For this reason, it was calculated by allocating the city-level value of municipal agricultural output at the ratio of the number of agricultural workers in each area in the 2015 national census.

As in the other sectors, the estimated outputs obtained in this way are adjusted by multiplying the value for each municipality by the ratio calculated by dividing the nationwide agricultural output in the IOT divided by the (estimated) municipal agricultural output (1.22) so that the total output for all municipalities matched the national value in the IOT. For example, the output of Tahara City, Aichi Prefecture, the largest agricultural producer in Japan in 2015, was estimated at ¥82.040 billion; this was adjusted by multiplying by the earlier ratio to reach an estimated output of ¥99.856 billion. The top 10 municipalities in terms of agricultural sector output calculated in this way are as follows:

Table 5.1 Top 10 Municipalities for Agricultural Output Value

	Prefecture	Municipality	Output (Million Yen)
1	Aichi	Tahara City	99,856
2	Ibaraki	Hokota City	87,672
3	Miyazaki	Miyakonojo City	87,599
4	Hokkaido	Notsuke County Bekkai Town	69,451
5	Chiba	Asahi City	66,700
6	Aomori	Hirosaki City	53,044
7	Aichi	Toyohashi City	50,317
8	Kagoshima	Kanoya City	48,784
9	Gunnma	Maebashi City	47,603
10	Kagoshima	Minami-Kyushu City	47,372

Tahara City, Aichi Prefecture, ranked first, is a region that takes advantage of its mild climate and the Toyokawa river water supply to cultivate vegetables for large cities, such as broccoli and tomatoes, and intensively cultivate flowers, such as chrysanthemums grown under artificial light, and roses. The

second-ranked city, Hokota in Ibaraki Prefecture, is the nation's top producer of melons according to the 2015 Crop Survey and is also a region where vegetables for the Greater Tokyo Area are widely grown. Miyakonojo City, Miyazaki Prefecture (No. 3), Betsukai, Notsuke District, Hokkaido (No. 4), and Kanoya City, Kagoshima Prefecture (No. 8) are also known for their livestock output. Hirosaki City in Aomori Prefecture ranked sixth, is known for its apples, and Minamikyushu City in Kagoshima Prefecture, ranked tenth, is known for its tea.

The forestry sector output is based on the prefectural forestry output published by the MAFF (2015) and is prorated by the number of forestry workers in each municipality according to the 2015 national census. Then, as in the other sectors, the value is adjusted by multiplying each municipality by the ratio (1.84) calculated by the national value of forestry sector output in the IO table/the national total value of forestry output.

As an example, in the case of Murakami City, Niigata Prefecture, which ranked first in Japan for forestry output in 2015, the estimated value of forestry output in Niigata Prefecture in 2015 was ¥396.9 million, which was multiplied by the proportion of the number of forestry workers in Murakami City to the number of forestry workers in Niigata Prefecture as recorded in the national census (0.163), resulting in a figure of ¥6.474 billion. Adjusting this value by the above ratio, we arrive at an estimated output for Murakami City of ¥11.887 billion. The top 10 municipalities in terms of output in the forestry sector calculated in this way are as follows:

Table 5.2 Top 10 Municipalities for Forestry Output Value

	Prefecture	Municipality	Output (Million Yen)
1	Niigata	Mukakami City	11,887
2	Nagano	Nagano City	11,108
3	Oita	Hita City	9,714
4	Niigata	Jyoetsu City	7,287
5	Nagano	Iida City	6,505
6	Oita	Saeki City	6,232
7	Nagano	Ueda City	6,049
8	Nagano	Ina City	5,820
9	Nagano	Matsumoto City	5,782
10	Niigata	Sado City	5,041

Murakami City, Niigata Prefecture, ranked first, accounts for more than 30% of Niigata Prefecture's timber material output, while Hita City, Oita Prefecture, ranked third, is known for its Hita cedar output. In addition, there are several output bases of major mushroom manufacturers in Nagano City, Nagano Prefecture, which ranks second.

The fishery sector output is based on the national value of fishery output published by the MAFF (2015) and is prorated according to the number of fishery workers in each municipality in the 2015 National Census. Since the national estimate of fisheries output matched the national value of fisheries in the IO table, it was used as-is as the value of fisheries output in the table of all municipalities.

For example, in Hakodate City, Hokkaido, which ranked first in the nation for fisheries output in 2015, the estimated national fisheries output in 2015 was ¥15,975,780,000, which was multiplied by the proportion of fishery workers in Hakodate City (0.020) to the number of fishery workers nationwide in the national census, yielding a resulting calculation of ¥32.160 billion. The top 10 municipalities in terms of fisheries sector output calculated in this way are as follows:

Table 5.3 Top 10 Municipalities for Fisheries Output Value

	Prefecture	Municipality	Output (Million Yen)
1	Hokkaido	Hakodate City	32,160
2	Hokkaido	Nemuro City	25,146
3	Ehime	Uwajima City	24,367
4	Miyagi	Ishinomaki City	24,086
5	Nagasaki	Tsushima City	23,816
6	Kumamoto	Amakusa City	19,036
7	Mie	Shima City	16,418
8	Nagasaki	Sasebo City	16,231
9	Saga	Saga City	14,391
10	Aichi	Nishio City	14,038

Hakodate City, Hokkaido, the first-ranked city, is known as a region with a large squid and konbu catch. Nemuro City in Hokkaido, ranked second, is a major region for saury and shellfish. Uwajima City in Ehime Prefecture (No.3) and Shima City in Mie Prefecture (No.7) are known for their aquaculture industries that take advantage of their rias coastline, while Ishinomaki City in Miyagi Prefecture (No.4) and Tsushima City in Nagasaki Prefecture (No.5) both have thriving coastal fishing and aquaculture industries.

6. Estimation of Public Sectors

In the 2016 EC-AS, as in the 2012 survey, national and local government establishments were not included in the survey coverage. Instead, the number of employment of these establishments can be obtained from the 2009 and 2014 Economic Census Basic Survey(EC-BS). By the way, the newest the 2021 EC-AS covers the business establishments of national and local governments.

Therefore, for sectors with high rate of public establishments , the domestic output by industry in V table of the 2016 IOT was prorated according to the number of employments in the 2014 EC-BS. Table 6.1 shows the list of industries in V table, where the domestic output is prorated according to the number of employments recorded in the EC-BS. Table 6.2 shows the list of industries from the 2014 EC-BS used in the proration.

Table 6.1 The List of Industries in V table, where the Domestic Output is Prorated According to the Number of Employments Recorded in the EC-BS

86 Transport-related services	125 School meals
093Education	126Research
095 Medical	127 Health
099Membership organizations not classified elsewhere	128Social insurance and social welfare
120 Sewerage	130 Education
121 Waste disposal	131 School meals
122 Transport Ancillary Services	132 Research
123 Public Affairs	133 Social Welfare
124 Education	134 Membership Organizations Not Elsewhere Classified

Figure 6.2 The List of Industries from the 2014 EC-BS Used in the Proration

36 Waterworks
48 Service related to transportation
71 Academic and development research institutes
81 School education
83 Medical industry
84 Health and sanitation
85 Social insurance, social welfare and nursing care business
88 Waste treatment
95 Miscellaneous services
S Public Service (except elsewhere classified)

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7. Estimation of Imputed Rents

Imputed rent is also outside the scope of the Economic Census, so it must be estimated separately.

The Housing and Land Survey was used to estimate imputed rent. In this estimation, we used data on the number of owner-occupied housing units by construction type (four categories) by municipality (Table 7.1) from the MIC's 2018 Housing and Land Survey. The following table shows data from Sapporo to Hakodate as an example.

Table 7.1 Example of the Number of Owned Houses by Building Type by Municipality

	Total	Detached houses	Tenement houses	Condominium	Others
Sapporo	447,900	285,900	8,200	153,000	800
Chuo-ku	50,540	12,210	180	38,050	100
Kita Ward	69,040	53,490	1,610	13,810	130
Higashi Ward	51,670	36,070	1,290	14,180	130
Shiroishi Ward	38,200	21,660	930	15,350	260
Toyohira Ward	44,830	20,810	1,210	22,730	90
Minami Ward	38,680	29,820	790	8,000	70
Nishi-ward	54,910	31,730	1,160	22,010	10
Atsubetsu Ward	29,270	20,160	30	9,080	-
Teine Ward	39,210	32,260	850	6,080	20
Kiyota Ward	31,540	27,670	200	3,670	-
Hakodate	70,160	61,720	1,910	6,220	310

Note) Only some cities are displayed. Source) MIC, Housing and Land Survey

Table 7.2 Examples of Rent per House (Yen/Month) by Building Type by Municipality

	Total	Detached houses	Tenement houses	Condominium	Others
Sapporo	117,686	76,079	115,780	89,550	52457.44
Chuo-ku	126,290	86,017	126,203	105,293	128734.2
Kita Ward	123,837	72,705	147,208	90,269	207880.66
Higashi Ward	115,581	77,012	92,141	82,732	62882.2
Shiroishi Ward	122,723	74,462	114,745	91,970	42038.08
Toyohira Ward	116,183	79,126	90,213	95,292	177561
Minami Ward	97,088	74,412	112428.6	71,959	16530.06
Nishi-ward	115,682	92,870	117,025	89,881	137148
Atsubetsu Ward	95,147	70,166	65877.28	72,326	-
Teine Ward	99,916	67,292	94018.32	75,040	102843
Kiyota Ward	102,857	70,637	122557.32	74,842	-
Hakodate	92,114	59,662	64,674	68,922	359583.3

Note) Only some cities are displayed. Source) MIC, Housing and Land Survey

Imputed rent was calculated by multiplying the values in Table 1 above by the per-house rent (Table 7.2) for each of the four building style categories by municipality, per the same survey.

Actual calculated imputed rent values are shown in Table 7.3. For example, there are 12,210 single-family houses in Sapporo's Chuo Ward. The rent per house is ¥86,017 per month. Annual imputed rent is, therefore, 12,210 units x ¥86,017 x 12 = ¥12,603,153,697 or ¥12.603 billion. Imputed rent by building type is ¥273 million for row houses, ¥48.077 billion for apartment buildings, and ¥154 million for others. Totaling the above yields imputed rent for Sapporo Chuo Ward, ¥61.107 billion.

Table 7.3 Example of Imputed Rent (Million Yen/Year)
by Municipal Building Type for Owned Houses

	Total	Detached houses	Tenement houses	Condominium	Others
Sapporo	437,324	261,013	11,393	164,414	503.591424
Chuo-ku	61,107	12,603	273	48,077	154.48104
Kita Ward	64,796	46,668	2,844	14,959	324.29383
Higashi Ward	48,936	33,334	1,426	14,078	98.096232
Shiroishi Ward	37,707	19,354	1,281	16,941	131.15881
Toyohira Ward	47,253	19,759	1,310	25,992	191.76588
Minami Ward	34,615	26,627	1065.82313	6,908	13.8852504
Nishi-ward	60,746	35,361	1,629	23,739	16.45776
Atsubetsu Ward	24,879	16,975	23.7158208	7,881	0
Teine Ward	32,509	26,050	958.986864	5,475	24.68232
Kiyota Ward	27,044	23,454	294.137568	3,296	0
Hakodate	52,153	44,188	1,482	5,144	1337.64988

Note) Only some cities are displayed. Source) MIC, Housing and Land Survey

However, the Housing and Land Survey does not survey all municipalities. Hence, some supplementary work is needed. A regression analysis was therefore performed for 1,087 municipalities, taking the imputed rent per unit per municipality estimated from the 2018 Housing and Land Survey as the explained variable and taxable income per taxpayer taken from the Statistics Bureau's "2018 Statistical Data of Municipalities" as the explanatory variable (Table 7.4). The regression coefficient is significant at the 1% level, and the standard error is 0.208 (yen, millions).

Table 7.4 Regression Analysis Results
(Dependent Variable: Imputed Rent per House by Municipality,
Independent Variable: Taxable Income per Taxpayer)

Multiple correlation coefficient R			0.766	
Multiple determination coefficient R2			0.587	
Adjusted R2			0.587	
Standard error			0.208	
Number of observations			1087	
	Coeff	Std. Effor	t	P−value
Intercept	−0.423972	0.032475	−13.055256	0.000000
Slope	0.423706	0.010788	39.276054	0.000000

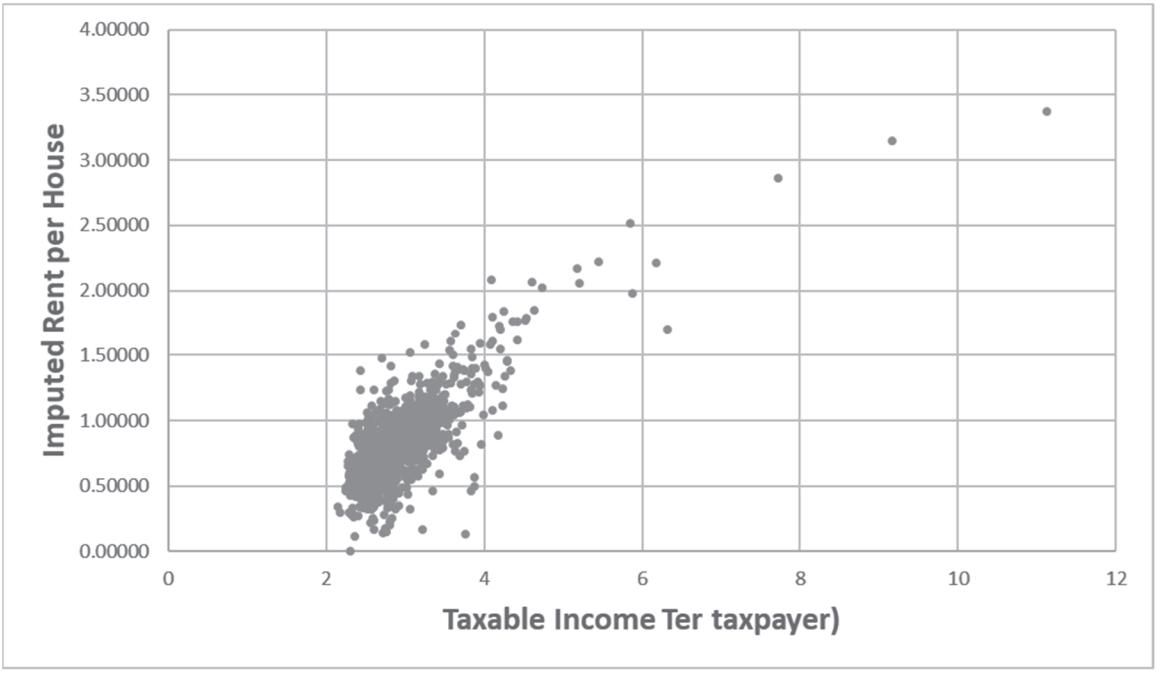

Figure 7.1 Scatter plot of Taxable Income Ter taxpayer and
Imputed Rent per House

Based on the results of the regression analysis, the imputed rent per unit is estimated using

-0.42397183 + 0.42370569 × taxable income per taxpayer

for municipalities not included in the 2018 Housing and Land Survey. This value was multiplied by the number of owner-occupied households according to the national census and supplemented as imputed rent = estimated imputed rent per unit x number of owner-occupied households according to the 2015 census.

8. Estimation of Household Consumption Expenditures

Household Consumption Expenditures are also outside the Scope of the Economic Census, so it must be estimated separately.

Candidates for statistical surveys to be used in estimating household consumption expenditures are the Family Revenue and Expenditure Survey (FIES) and the National Household Expenditure Survey(NHES), produced by the Statistics Bureau. Since neither covers all municipalities, estimates must be created in either case. In this paper, as in Suga (2019), we use aggregate results by household attributes by item and distribution of households by attribute by municipality from the national census to estimate subregions. In this case, we assume that households with the same attributes have the same level and composition of consumption expenditures in any municipality nationwide. Considering that price levels vary by region, this assumption is believed to deviate from the actual situation. However, we consider this unavoidable since there is no data on price levels that surveys all cities, towns, and villages.

The NHES is conducted every five years, and the survey year is different from the years in which the IOT is compiled, and survey months are limited to September, October, and November. Since the FIES is a monthly survey, it does not have this problem, but the sample size is small; hence, aggregating overly granular item classification will lead to too large a sample error. In this study, we decided to use the FIES while paying attention to sample error.

The aggregate results by household attribute by item, which can be used for estimation in combination with the census results, include totals by the number of household members, age group of the head of household, occupation of the head of household, and industry of the head of household. We refrained from using data by the occupation of the head of household and by industry of the head of household because it is unlikely that the level and breakdown of consumption expenditures differ significantly by occupation and industry and because the number of unknowns on the census side is too large to be overlooked. On the other hand, it is clear that the level of consumption expenditures is affected by the number of household members and that the breakdown of consumption expenditures differs depending on the age group of the head of the household. Thus, in this paper, we used cross-tabulated results by single or dual-occupancy households and by the age group of the head of the household.

That is, the amount of expenditure by households with two or more individuals, taken from the FIES (Table 8.1), was multiplied by the number of non-single-individual households taken from the Population Census (Table 8.2) to estimate consumer expenditures by item by municipality (Table 8.3, example of two or more individuals).

Table 8.1 Example of Consumption Expenditure by Age Group of Household Head by Item According to Family Income and Expenditure Survey (Unit: Yen, 2015, Two-or-More-Person Household)

Item	29 and under	30～39	40～49	50～59	60～69	70 and over
Consumption expenditure	2,982,391	3,256,187	3,835,012	4,079,599	3,471,470	2,873,444
Food	628,816	809,960	958,971	1,010,110	996,704	891,428
Cereals	47,225	65,304	79,795	83,311	79,180	74,113
Rice	9,726	14,092	19,460	23,772	25,027	27,062
Bread	21,121	30,254	35,724	34,363	29,957	25,819
Plain bread	4,981	8,046	9,377	9,162	9,304	9,078
Other bread	16,140	22,208	26,347	25,201	20,653	16,741
Noodles	12,648	16,241	19,274	19,715	18,287	15,891
Raw Udon/Soba	2,135	2,802	3,344	3,519	3,729	3,571
Dry Udon/Soba	867	1,248	1,581	2,371	3,146	3,567

Source) Ministry of Internal Affairs and Communications, Annual Report on Family Income and Expenditure Survey 2015 Note) Only some items are shown

Table 8.2 Example of Number of Households by Age Group of Household Head by Municipality According to the Population Census (2015, Other than Single)

Municipalities	29 and under	30～39	40～49	50～59	60～69	70 and over
Sapporo	20,707	76,115	109,924	101,325	118,360	117,825
Chuo-ku	2,831	9,148	13,318	11,500	10,851	10,990
Kita Ward	2,603	10,422	15,867	14,244	17,218	17,145
Higashi Ward	3,392	11,293	15,118	12,620	15,021	14,879
Shiroishi Ward	3,113	9,444	11,848	9,935	10,962	11,303
Toyohira Ward	3,006	9,404	12,510	10,772	11,672	12,589
Minami Ward	880	4,042	6,691	7,898	10,563	11,357
Nishi-ward	2,239	8,991	12,665	11,326	13,233	13,822
Atsubetsu Ward	983	4,175	7,313	7,823	9,309	9,182
Teine Ward	1,079	5,201	7,616	7,949	10,776	9,405
Kiyota Ward	581	3,995	6,978	7,258	8,755	7,153
Hakodate	2,261	8,484	12,857	12,736	18,172	20,862

Source) Ministry of Internal Affairs and Communications, 2015 Population Census Note) Only some municipalities are displayed.

In this case, single-individual households in the FIES are virtually equivalent to single-individual households in the national census, and two or more individual households in the FIES are understood to be virtually equivalent to non-single-individual households in the national Population Census. Strictly speaking, student "single-individual households" are not included among "single-individual households" in the FIES, which constitutes a difference.

Table 8.3 shows the item categories in the FIES. Table 8.4 converts these into the IOT classifications. In this case, we did not force a correspondence between item classifications in the FIES and IOT classifications which did not align well (e.g., "metallic minerals," "coal, oil and natural gas," and "non-metallic minerals"). Since Table 8.4 shows purchaser prices, while Table 8.5 converts them to producer prices using freight and commercial margin rates from the household consumption expenditure sector.

Table 8.3 Example of Household Consumption Expenditure by Item by Municipality

(Unit: Million Yen, Two or More Households)

Item	Sapporo	Chuo-ku	Kita Ward	Higashi Ward	Shiroishi Ward	Toyohira Ward	Minami Ward	Nishi-ward
Consumption expenditure	1,893,973	205,469	269,696	251,250	196,536	208,200	142,970	216,385
Food	505,437	54,190	72,127	66,760	52,006	55,240	38,874	57,787
Cereals	41,265	4,426	5,890	5,447	4,243	4,509	3,175	4,719
Rice	11,973	1,258	1,714	1,565	1,210	1,294	955	1,369
Bread	16,737	1,816	2,385	2,221	1,736	1,840	1,261	1,914
Plain bread	4,845	519	692	640	498	530	373	555
Other bread	11,891	1,298	1,693	1,581	1,238	1,310	888	1,360
Noodles	9,651	1,041	1,376	1,278	997	1,058	735	1,103
Raw Udon/Soba	1,844	196	263	243	189	201	143	211
Dry Udon/Soba	1,320	136	189	171	132	141	109	151

Source) Estimated by the author based on the Ministry of Internal Affairs and Communications 2015 Family Income and Expenditure Survey and the 2015 National Census by the Ministry of Internal Affairs and Communications.
Note) Only some items and municipalities are displayed.

Table 8.4 Examples of Household Consumption Expenditures by Sector by Municipality

(Unit: Million Yen Indicated by Purchaser Price, Two or More Households)

Sector		Sapporo	Chuo-ku	Kita Ward	Higashi Ward	Shiroishi Ward	Toyohira Ward	Minami Ward	Nishi-ward
011	Crop farming	58,918	6,124	8,446	7,682	5,925	6,343	4,769	6,739
012	Livestock	4,921	527	703	650	506	537	379	563
013	Agricultural services	4,862	521	694	636	493	524	374	553
015	Forestry	4,150	440	593	546	424	451	326	474
017	Fishery	25,318	2,624	3,632	3,294	2,536	2,718	2,059	2,895
061	Coal, crude oil, natural gas	–	–	–	–	–	–	–	–
062	Other mining	–	–	–	–	–	–	–	–
111	Groceries	279,534	29,991	39,897	36,919	28,758	30,553	21,484	31,965
112	Beverage	49,920	5,353	7,123	6,591	5,132	5,449	3,834	5,703
113	Feed and Organic Fertilizer (Except Separately Listed)	3,661	386	524	475	365	391	291	416
114	Tobacco	6,612	722	940	883	692	730	489	755

Source) Estimated by the author based on the Ministry of Internal Affairs and Communications 2015 Family Income and Expenditure Survey and the 2015 National Census by the Ministry of Internal Affairs and Communications.
Note) Only some sectors and municipalities are displayed. Items that do not correspond well between the item classification of the Family Income and Expenditure Survey and the sectors of the input-output table are not forcibly matched..

Table 8.5 Examples of Household Consumption Expenditures by Sector by Municipality

(Unit: Million Yen at Producer Prices, Two-or-More-Person Households)

Sector		Sapporo	Chuo-ku	Kita Ward	Higashi Ward	Shiroishi Ward	Toyohira Ward	Minami Ward	Nishi-ward
011	Crop farming	27,673	2,876	3,967	3,608	2,783	2,979	2,240	3,165
012	Livestock	3,629	389	518	479	373	396	280	415
013	Agricultural services	4,862	521	694	636	493	524	374	553
015	Forestry	2,122	225	303	279	217	231	166	243
017	Fishery	12,954	1,342	1,858	1,685	1,297	1,391	1,054	1,481
061	Coal, crude oil, natural gas	–	–	–	–	–	–	–	–
062	Other mining	–	–	–	–	–	–	–	–
111	Groceries	162,467	17,431	23,189	21,458	16,714	17,758	12,487	18,579
112	Beverage	30,171	3,235	4,305	3,984	3,102	3,293	2,317	3,447
113	Feed and Organic Fertilizer (Except Separately Listed)	922	97	132	120	92	98	73	105
114	Tobacco	4,726	516	672	631	495	522	350	540

Source) Estimated by the author based on Ministry of Internal Affairs and Communications 2015 Family Income and Expenditure Survey, Ministry of Internal Affairs and Communications 2015 Population Census, and Ministry of Internal Affairs and Communications 2015 Input-Output Table.
Note) Only some sectors and municipalities are displayed. Producer prices were converted to purchaser prices using commercial margins and freight rates in the household consumption expenditure sector of the input-output table.

The same task was performed for single-individual households (Table 8.6) and summed with expenditures by households with two or more members (Table 8.7).

Table 8.6 Example of Household Consumption Expenditure by Sector by Municipality

(Unit: Million Yen in Producer Prices, Single-Person Households)

Sector		Sapporo	Chuo-ku	Kita Ward	Higashi Ward	Shiroishi Ward	Toyohira Ward	Minami Ward	Nishi-ward
011	Crop farming	7,804	1,322	1,091	1,071	978	989	499	811
012	Livestock	826	146	116	114	105	107	49	84
013	Agricultural services	1,716	323	232	238	229	225	91	174
015	Forestry	446	79	63	61	57	58	27	45
017	Fishery	2,719	463	379	373	342	345	172	283
061	Coal, crude oil, natural gas	–	–	–	–	–	–	–	–
062	Other mining	–	–	–	–	–	–	–	–
111	Groceries	49,558	9,342	7,145	6,839	6,326	6,621	2,694	4,805
112	Beverage	14,623	2,889	2,111	2,026	1,902	1,994	723	1,385
113	Feed and Organic Fertilizer (Except Separately Listed)	342	61	47	47	44	44	20	35
114	Tobacco	5,300	1,071	750	738	706	726	246	504

Source) Estimated by the author based on Ministry of Internal Affairs and Communications 2015 Family Income and Expenditure Survey, Ministry of Internal Affairs and Communications 2015 Population Census, and Ministry of Internal Affairs and Communications 2015 Input-Output Table.
Note) Only some sectors and municipalities are displayed.

Table 8.7 Example of Household Consumption Expenditure by Sector by Municipality

(Unit: Million Yen in Producer Prices, All Households, Before Adjustment)

Sector		Sapporo	Chuo-ku	Kita Ward	Higashi Ward	Shiroishi Ward	Toyohira Ward	Minami Ward	Nishi-ward
011	Crop farming	35,478	4,199	5,057	4,679	3,761	3,968	2,739	3,976
012	Livestock	4,455	535	635	593	477	503	329	499
013	Agricultural services	6,577	844	926	875	722	749	465	727
015	Forestry	2,568	304	366	340	273	288	193	288
017	Fishery	15,673	1,805	2,237	2,059	1,640	1,735	1,226	1,764
061	Coal, crude oil, natural gas	–	–	–	–	–	–	–	–
062	Other mining	–	–	–	–	–	–	–	–
111	Groceries	212,025	26,773	30,334	28,296	23,040	24,379	15,181	23,384
112	Beverage	44,794	6,124	6,416	6,010	5,004	5,288	3,041	4,831
113	Feed and Organic Fertilizer (Except Separately Listed)	1,264	158	179	167	136	142	93	140
114	Tobacco	10,026	1,587	1,422	1,369	1,201	1,248	596	1,044

Source) Estimated by the author based on Ministry of Internal Affairs and Communications 2015 Family Income and Expenditure Survey, Ministry of Internal Affairs and Communications 2015 Population Census, and Ministry of Internal Affairs and Communications 2015 Input-Output Table.
Note) Only some sectors and municipalities are displayed.

Table 8.8 shows the private-sector consumption expenditure vector of the IOT, which is assigned to the household consumption expenditure vector of the IOT using the per-municipality breakdown of consumption expenditure by sector created from the FIES.

Table 8.8 Example of Household Consumption Expenditure by Sector by Municipality

(Unit: Million Yen in Producer Prices, All Households, Before Adjustment)

Sector		Sapporo	Chuo-ku	Kita Ward	Higashi Ward	Shiroishi Ward	Toyohira Ward	Minami Ward	Nishi-ward
011	Crop farming	43,037	5,093	6,135	5,676	4,562	4,813	3,322	4,824
012	Livestock	3,846	462	548	512	412	434	284	430
013	Agricultural services	7,000	899	986	931	769	797	495	774
015	Forestry	2,818	334	401	374	300	316	212	316
017	Fishery	5,248	605	749	689	549	581	411	591
061	Coal, crude oil, natural gas	0	0	0	0	0	0	0	0
062	Other mining	−104	−14	−15	−14	−12	−12	−7	−11
111	Groceries	328,961	41,539	47,064	43,902	35,747	37,824	23,553	36,281
112	Beverage	77,707	10,624	11,130	10,426	8,681	9,173	5,275	8,381
113	Feed and Organic Fertilizer (Except Separately Listed)	3,010	376	426	397	325	339	222	334
114	Tobacco	61,179	9,685	8,678	8,352	7,328	7,616	3,637	6,371

Source) Estimated by the author based on Ministry of Internal Affairs and Communications 2015 Family Income and Expenditure Survey, Ministry of Internal Affairs and Communications 2015 Population Census, and Ministry of Internal Affairs and Communications 2015 Input-Output Table.
Note) Only some sectors and municipalities are displayed.

9. Cluster Analysis of Regional Output by Municipality

A non-hierarchical cluster analysis was conducted based on the output composition ratios by sector in each municipality, calculated using the table for all municipalities, to obtain an overall picture of the estimation results. The k-means method was used, and the number of clusters was set at 6.

Cluster 1 was defined as commercial and service-oriented areas (below referred to as "commercial areas") distributed across the centers of the five major metropolitan areas and provincial cities.

Cluster 2 was defined as regions focused on various manufacturing industries other than transportation machinery and equipment manufacturing, distributed across coastal areas and the periphery of the five metropolitan areas (referred to below as "industrial areas").

Cluster 3 was defined as regions in which the electric power industry has an overwhelmingly high share, regions with nuclear power plants, thermal power plants etc. (referred to below as "power plant locating areas").

Cluster 4 refers to the Mikawa region of Aichi Prefecture and other regions where automobile factories and shipyards are located. The share of the transportation machinery and equipment manufacturing industry is overwhelmingly high (hereinafter referred to as "transportation machinery manufacturing areas").

Cluster 5 was defined as regions focused mainly on agricultural and food manufacturing industries, distributed across Hokkaido, southern Kyushu, and other regions (referred to below as "agricultural areas).

Cluster 6 was defined as a region with a high share of public and construction industry, regions in which the local economy is supported by Self-Defense Forces bases and public works projects (referred to below as "public-affairs areas").

The number of data (and composition ratio) for each cluster was 823 (43.4%) for Cluster 1 (commercial areas), 454 (24.0%) for Cluster 2 (industrial areas), 43 (2.3%) for Cluster 3 (power plant location areas), 73 (3.9%) for Cluster 4 (transportation machinery areas), 207 (10.9%) for Cluster 5 (agricultural areas) and 294 (15.5%) for Cluster 6 (public-affairs areas). Figures 9.1 through 9.6 visualize each cluster spatially using QGIS.

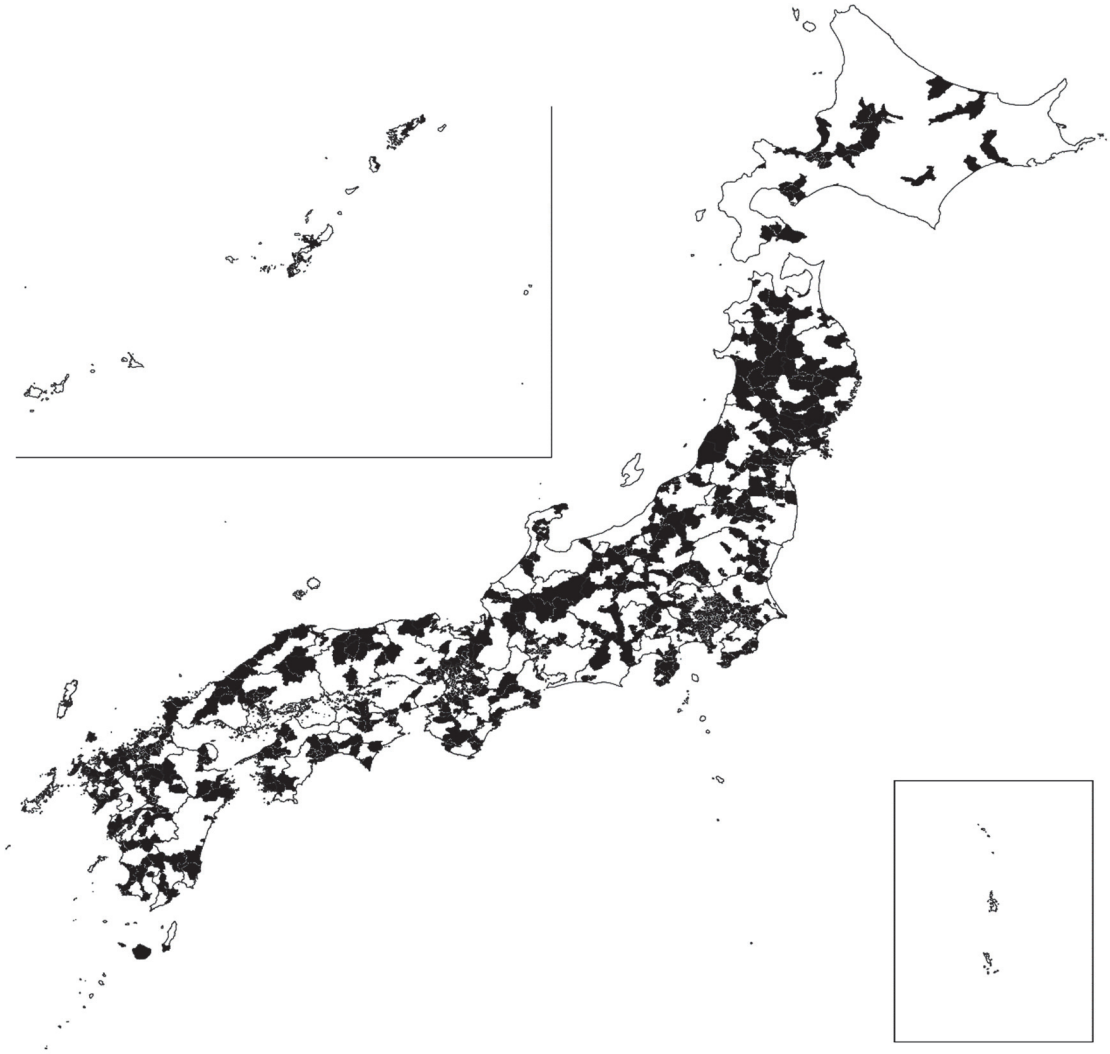

Figure 9.1 Cluster 1 (Commercial Area)

Note) Based on "National Land Numerical Information (Administrative Area Data)" (Ministry of Land, Infrastructure, Transport and Tourism) (https://nlftp.mlit.go.jp/ksj/gml/datalist/KsjTmplt-N03-v2_3.html)

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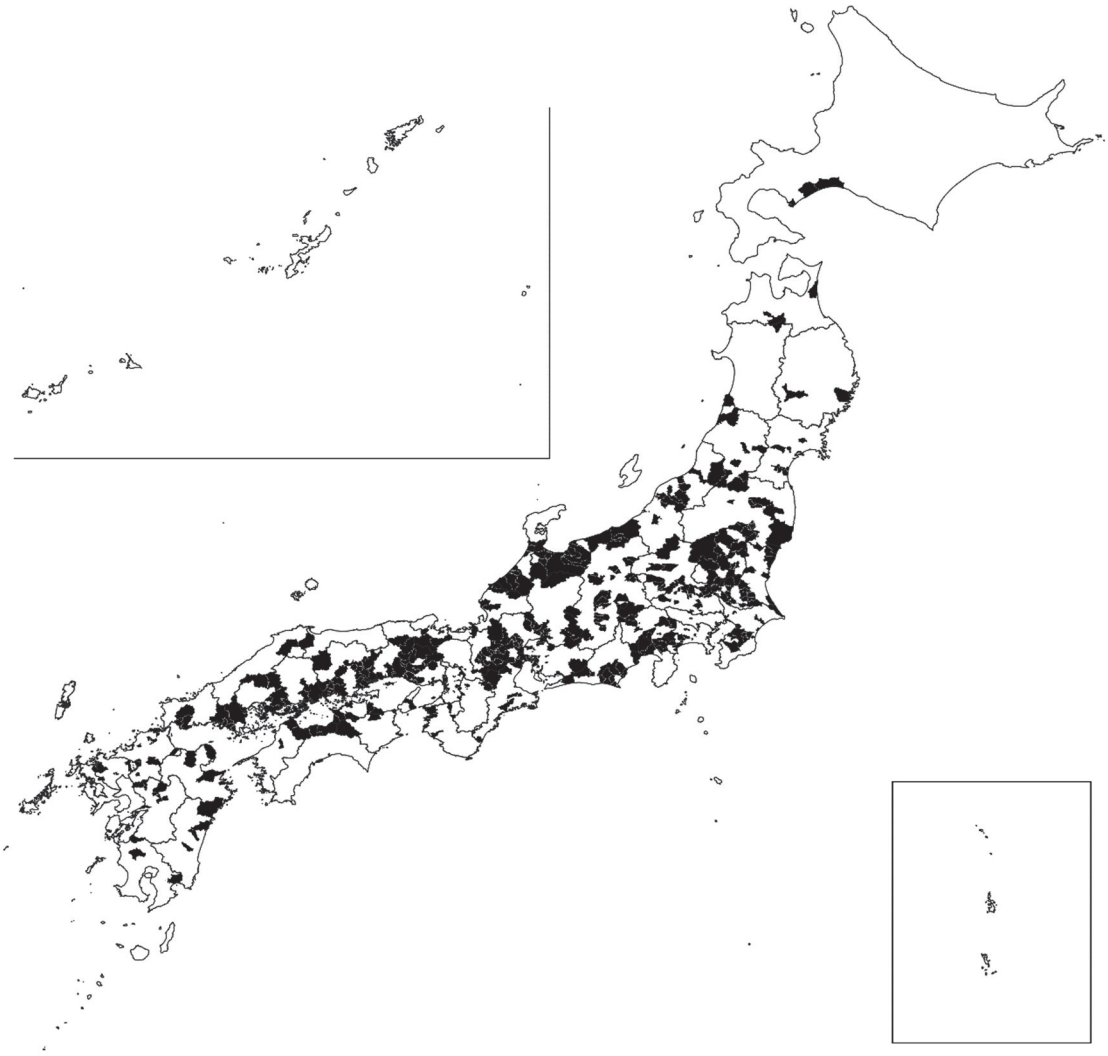

Figure 9.2 Cluster 2 (Industrial Area)

Note) Based on "National Land Numerical Information (Administrative Area Data)" (Ministry of Land, Infrastructure, Transport and Tourism) (https://nlftp.mlit.go.jp/ksj/gml/datalist/KsjTmplt-N03-v2_3.html)

Figure 9.3 Cluster 3 (Power Plant Locating Area)

Note) Based on "National Land Numerical Information (Administrative Area Data)" (Ministry of Land, Infrastructure, Transport and Tourism) (https://nlftp.mlit.go.jp/ksj/gml/datalist/KsjTmplt-N03-v2_3.html)

Figure 9.4 Cluster 4 (Transportation Machinery Area)

Note) Based on "National Land Numerical Information (Administrative Area Data)" (Ministry of Land, Infrastructure, Transport and Tourism) (https://nlftp.mlit.go.jp/ksj/gml/datalist/KsjTmplt-N03-v2_3.html)

Figure 9.5 Cluster 5 (Agricultural Area)

Note) Based on "National Land Numerical Information (Administrative Area Data)" (Ministry of Land, Infrastructure, Transport and Tourism) (https://nlftp.mlit.go.jp/ksj/gml/datalist/KsjTmplt-N03-v2_3.html)

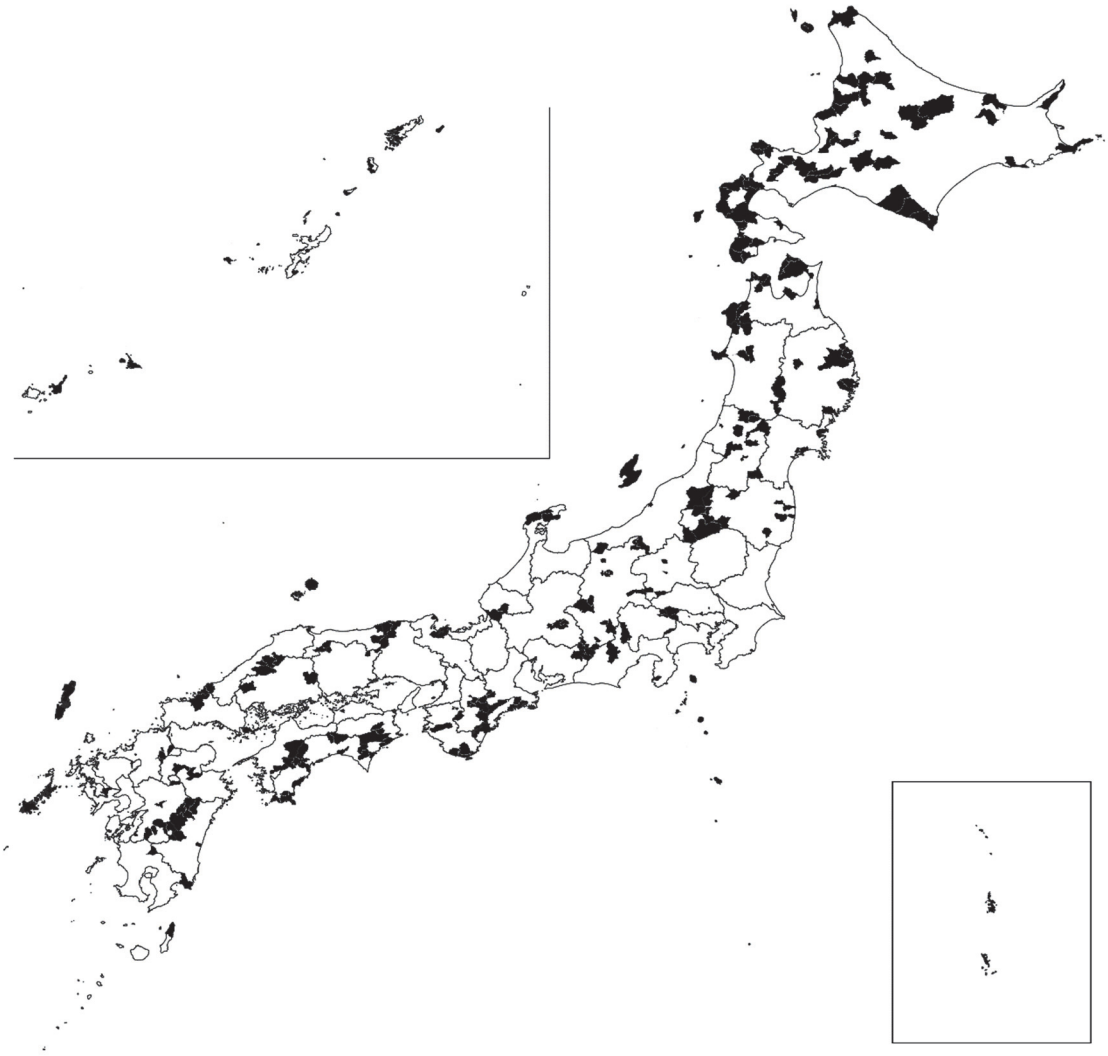

Figure 9.6 Cluster 6 (Public Affairs Area)

Note) Based on "National Land Numerical Information (Administrative Area Data)" (Ministry of Land, Infrastructure, Transport and Tourism) (https://nlftp.mlit.go.jp/ksj/gml/datalist/KsjTmplt-N03-v2_3.html)

10. Future Outlook

The estimation results in this paper are the first version. Be that as it may, the estimated municipalities table needs to be examined closely in the future, and depending on the results, the estimates may be changed, and a second version may be prepared. As soon as it is determined that a certain level of quality has been achieved, it will be released as teaching material for the statistical training of local public officials in April 2023 from the Statistical Research and Training Institute. Researchers can use it for analysis by partnering with local public officials who have taken statistical training.

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オケージョナル・ペーパー（既刊一覧）

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102	わが国の1980年代後半期以降の社会移動に関する一考察 —純移動選好度の人口加重平均値による地域の転入・ 転出超過状況の評価—	2019.09
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107	地租改正にともなう土地評価の改定：東京府日本橋区・京橋区の事例	2020.05
108	駿河国人別調と甲斐国人員運動調における動態把握 —わが国における人口動態統計前史（1）—	2020.05
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110	明治4年「一般戸籍の法」における人口の社会動態の把握	2020.06
111	明治前期の戸籍法制と社会移動の統計的把握 —明治4年「戸籍の法」による社会移動把握の制度改定を中心に—	2020.07
112	甲斐国現在人別調における人口概念	2020.07
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119	自動車保有台数からみるSS過疎地に関する考察	2021.08
120	高齢化率と経年変化からみる事業所数モデルの考察	2021.09
121	甲斐国現在人別調における調査過程	2021.10
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再生紙使用 VEGETABLE OIL INK